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ABSTRACT

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Technical Note 1-81

COMPUTER AIDED AUTHORING AND EDITING

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A PAPER PRESENTED AT THE MEETING OF THE
SOCIETY FOR APPLIED LEARNING TECHNOLOGY

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ABSTRACT

Using computers to author and edit text is now feasible and economical. This article describes two elements of a computer based publishing system which aid authors by automatically generating certain types of training material, and in writing easily understood text. The routines are operating on the Training Analysis and Evaluation Group's mini-computer and are being developed for use in the Navy's computer based publishing system.

INTRODUCTION

Publishing is becoming a computer based industry. Many publishers are now using computer routines to replace labor intensive methods of text processing, page make-up, and typesetting. Computer based print-on-demand systems are now real.

This is not just someone else's revolution -- using computer aids changes the primary processes and products of the instructional technologist. Using computer aids is transforming the way we create, reproduce, distribute and use instructional materials.

Authoring is one of the latest phases of instructional publishing to be computer aided. For the past three years the Navy's Training Analysis and Evaluation Group (TAEG) has been pioneering the development of computer aids for authors. It has been our goal to reduce the cost and time required for authors to create documents that teach effectively. The work is sponsored by the Chief of Naval Education and Training and the Naval Technical Information Presentation Program of the David W. Taylor Naval Ship Research and Development Center. The Navy's authoring aids go beyond word processing. In these new programs the computer is used to:

- automatically construct illustrated exercises and tests from basic job-task information stored in a data base.
- systematically analyze draft text and note changes that will make the text more readable for a targeted audience.

The purpose of this paper is to establish that it is reasonable for authors to use computer routines for these purposes. The paper describes some of the routines we are using and makes observations on what it is like to author and edit materials with these computer aids.

What can computers do for authors?

Computers can be used in several ways in authoring instructional materials. For instance, the computer can rearrange the same information for various purposes. For example, an initial presentation of information can be transformed into drill and practice exercises, tests with answer pages and remedial instruction loops. Also the computer can automatically merge information from various files. For instance, standard directions for a certain type of test item can be pulled from one file and placed over a list of test items from another file. While the test items would be unique to one document, the directions would be used in many documents. Therefore when the need is to repeat the information in various forms or to repeat it in various places, the computer is a candidate for aiding the author.

Also the computer can aid the author to improve the readability of text by flagging uncommon words and long sentences and by making suggestions for editing difficult words, phrases and sentences.

There are two parts to this paper. The first concerns generating materials with computer aids, and the second, using computer editing to improve readability.

COMPUTER AIDED AUTHORING

Recently the TAEG computer aided authoring routines were used in writing 600 pages of instructional material for a series of pocket booklets to teach

weather symbols to the Navy's new Aerographer Mates. These sailors need to learn the symbols so they can plot them on weather maps. When the sailor reads a number in a certain position in a weather message representing the present weather at a certain station, he must write the proper graphic symbol at the station's location on the map. Later, to read the map, the sailor must be able to recall the meaning of the symbol. For example, "45" is plotted ≡ which means "Fog, sky NOT discernible, no appreciable change during past hour." There are 100 of these number, symbol, meaning sets. The learning of these many paired associates is not a trivial task.

In developing instructional material to teach this skill, first the task was divided into parts. Documents with similar structure were developed for each of the parts. In general each has the following blocks of information:

- an introduction with the learning objective and a discussion on why the student needs to know this information.
- an optional criterion test for use by students to decide if they already know the information.
- a description of how the lesson is organized to carry out the learning objective.
- material on the first set of symbols including directions for study, presentation of the symbols with meanings and memory aids, practice exercises, and a self-test.
- similar information on later sets of symbols.
- large practice exercises made up of symbols from all sets.
- criterion tests.
- reinforcing statements and suggestions for refresher training.
- an index.

There were four steps in the authoring of these materials. The first was to place basic data in a data base -- the alpha-numeric codes for the graphic symbols, their meanings and memory aids. Also, the title, authors, publisher's name, and date of publication, the learning objective, the type of student that will use the module, and the reasons why he will need the skill being taught were put into the data base. While keying the data was done quickly, the preliminary task of creating the memory aids took significantly more time. It took about 2 hours to enter information on 50 weather symbols into the data base.

In the second step, computer routines were used to create all the pages in the lesson. These routines can only be used in creating materials for paired associate type learning tasks. About 5 minutes were required to perform this operation which resulted in 154 pages of instructional materials.

In the third step, the material was displayed and minor editorial changes were made using word processing type routines.

The last step was to prepare typeset camera ready copy. This was another automated step. A special computer routine inserted typesetting commands into the textstream created in the earlier steps. This modified textstream was then sent over a standard telephone line to a phototypesetter. The typesetter had a special font with the graphic symbols. The typesetter automatically created camera ready copy with graphic symbols in place. It took about 7 minutes to insert the typesetting commands into the textstream for the 154 pages, and another 90 minutes to send the signals to the typesetter. The typesetter was operated by the vender, and the time required was about 3 hours. However, once started, these are all unmanned operations. Figure 1 contains a sample of the typesetter output.

The results, 154 pages of camera ready copy, were produced in about two and one half hours of an author's time. The time required to author a lesson will vary considerably from task to task and from author to author. The major factors that influence time are (1) difficulty in creating the memory aids, (2) the extent of the editing, and (3) the speed of the computers. For a more detailed description of the routines used to produce these materials see Brady, Parrish, Guitard and Aagard (1) and Keeler (2).

As stated previously, the purpose of this paper is to establish that it is reasonable for authors to use computer routines as aids in authoring instructional material for technical training. In support of this thesis we

109

SYMBOL SET 5

The numbers in this set are:

40 41 42 43 44 45
46 47 48 49

You will learn to recognize and coordinate these numbers with their respective symbols in the next few pages.

Go to 110

110

SYMBOL SET 5: LEARN THE SYMBOLS

Directions

1. Look carefully on the next page at each GRAPHIC SYMBOL for each number.
2. Recall the MEMORY AID and GRAPHIC SYMBOL as you look at the NUMBER.
3. Understand how the MEMORY AID helps you coordinate the SYMBOL with a NUMBER.
4. Cover the symbols, then look at each NUMBER and recall the GRAPHIC SYMBOL.
5. Repeat this 4 or 5 times for each of the numbers.

Go to 111

111

SYMBOL SET 5: LEARN THE SYMBOLS

Graphic Symbol	Number	Memory Aid
	40	first column
	41	1 right of in first column
	42	2 right of in first column
	43	2 left of in column 5
	44	1 left of in column 5
	45	column 5
	46	1 right of in column 5

Go to 112

113

SYMBOL SET 5: PRACTICE

Directions

1. Recall all directions before you practice.
2. Try to recall the graphic symbol for each number in the exercise on page 114.
3. WRITE your first impression of the graphic symbol.
4. If the graphic symbol is difficult to remember, recall the memory aid first, then recall the graphic symbol.
5. Check your answer immediately in the answer section below the practice numbers.

Go to 114

114

SYMBOL SET 5: PRACTICE

Practice Numbers

47 45 46 43 41 43 47
46 41 45 45 46 43 41
47 41 47 46 43 45 47
43 46 41 45 45 41 46
43 47 45 43 46 41 47

Number	Graphic Symbol
46	
43	
41	
45	
47	

Go to 115

117

SYMBOL SET 5: TEST YOURSELF

Directions

1. WRITE the GRAPHIC SYMBOL for each number in the self test. Use scratch paper.
2. If you want a memory aid ..... go to 118
3. Refer to the memory aids only when you can't think of the symbol.

Self Test

44	42
45	41
49	43
40	46
48	47

For Answers ..... Go to 119

Figure 1. Sample Pages Produced with Computer Authoring Routines and Automatic Insertion of Typesetting Commands.

have shown how we are authoring material for paired associate type learning tasks. What about the more significant learning tasks such as operating or maintaining a piece of equipment, or recalling equipment nomenclature and theory of operation? Is it reasonable to use computer routines for authoring in this larger arena?

During the past six months TAEG's computer aided authoring team has been studying whether it is feasible to machine produce training materials across a broad spectrum of training tasks. We have developed machine producible formats for teaching procedures, system theory and nomenclature, classifying visual objects, and the application of rules.

While we have not completed the design of an automated system for authoring these types of materials, two criteria for machine producibility have become clear.

First, computer based authoring aids will be most useful when there is a high level of redundancy in the material being authored. (See figure 2.) Since we are interested in authoring training materials, not novels, information to be learned is usually repeated over and over again for various purposes (e.g., in overviews, presentations, exercises, quizzes, chapter tests, course examinations). In addition, directions such as for taking or scoring tests are repeated for each test.

SYMBOL SET 2: PRACTICE DEFINING THE SYMBOLS

Practice	==	☺	<	(((·)))	)·(
Symbols	)·(	==	(((·)))	<	☺
	(((·)))	☺	==	)·(	<
	☺	)·(	<	==	(((·)))
	)·(	<	==	(((·)))	☺

Symbol	Definition
==	Shallow fog in patches
<	Lightning
(((·)))	Dry thunder
☺	Virga
)·(	Distant precipitation

Figure 2. Example of Redundancy in a Page of Training Material.

Second, computer routines are very useful for arranging information into complex formats. TAEG has a preliminary version of a routine for arranging illustrations and related boxes of text on a page. Figure 3 shows a hand made page with 3 illustrations and 3 boxes of text related to specific points on the illustrations. This type of layout has many uses in training materials and in job performance aids. However, it is very expensive to produce many pages by hand. Given the pieces of information that need to appear on a page like this, the TAEG routine will be able to determine a useful layout and then organize the information accordingly.

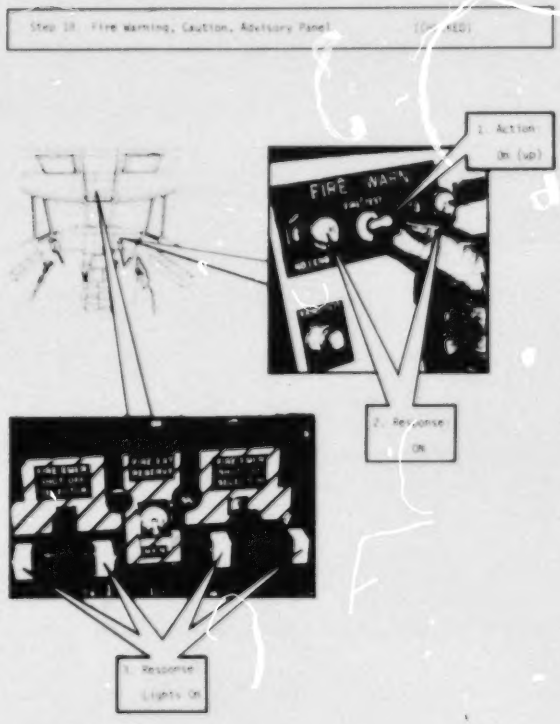

Figure 3. Manually Prepared Page Representing the Layout of a Computer Generated Page.

What will it be like for you to author instructional material with the new authoring aids being developed?

There will be six steps:

1. Call up a standard page sequence diagram for the class of tasks to be taught (see figure 4) and change it if necessary to meet your needs. This sets up the sequence of learning events.

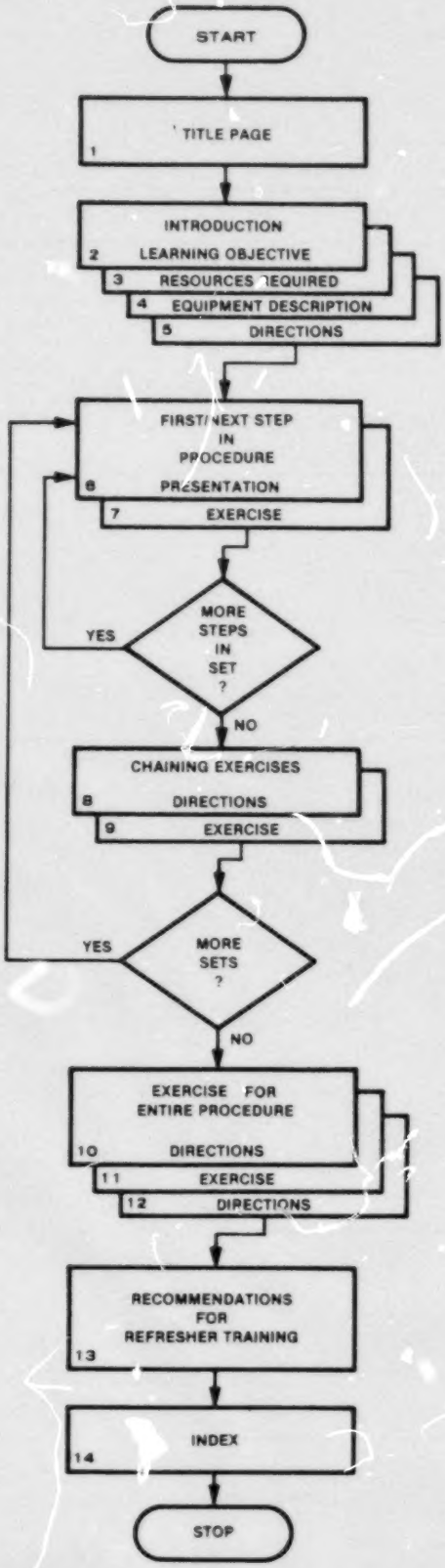

Figure 4. Sequence Diagram for Material to Teach Procedures.

2. Call up any of the detailed page templates named in the page sequence diagram. (See figure 5.) Modify them to meet your needs. If in changing the page sequence in step 1 you add new pages to the sequence, you must create templates for these pages. An authoring language will be available for use in creating page templates.

(1. page size: 8.5 x 11)
(2. Margins: T=1, B=1, R=.75, L=.75)

(3. page #)	(3. page #)
(4. step #"n") (5. step name)	
(6. Arrange overview, close-up view(s), and blocks of related text for step #"n" according to routine #1.)	

Figure 5. Sample Page Template for the Type of Page Shown in Figure 3.

3. Use an interactive data capturing routine (see figure 6) to enter into the data base the specific job-task information required in the lesson being authored.

4. Run the authoring routines. The computer automatically organizes the data in the data base into the entire sequence of pages from the title page to index as called for in the page sequence diagram.

5. Display the pages and edit them, as necessary, using various routines that coach you on how to improve the comprehensibility of the materials. (See the illustration of the editing routines in figures 7 and 8.)

6. Output the final pages in the selected medium.

Two more points have become clear to us as we have worked with computer aided authoring routines:

First, there is a firm requirement for the wide use of graphics in technical training material. Most Navy jobs are highly visual in character. For instance, in operating a piece of equipment, the sailor must locate instruments, read them, find switches, and reset them to a new position. Because of the visual nature of the task, instructional materials intended to teach the operation of equipment must make wide use of visuals.

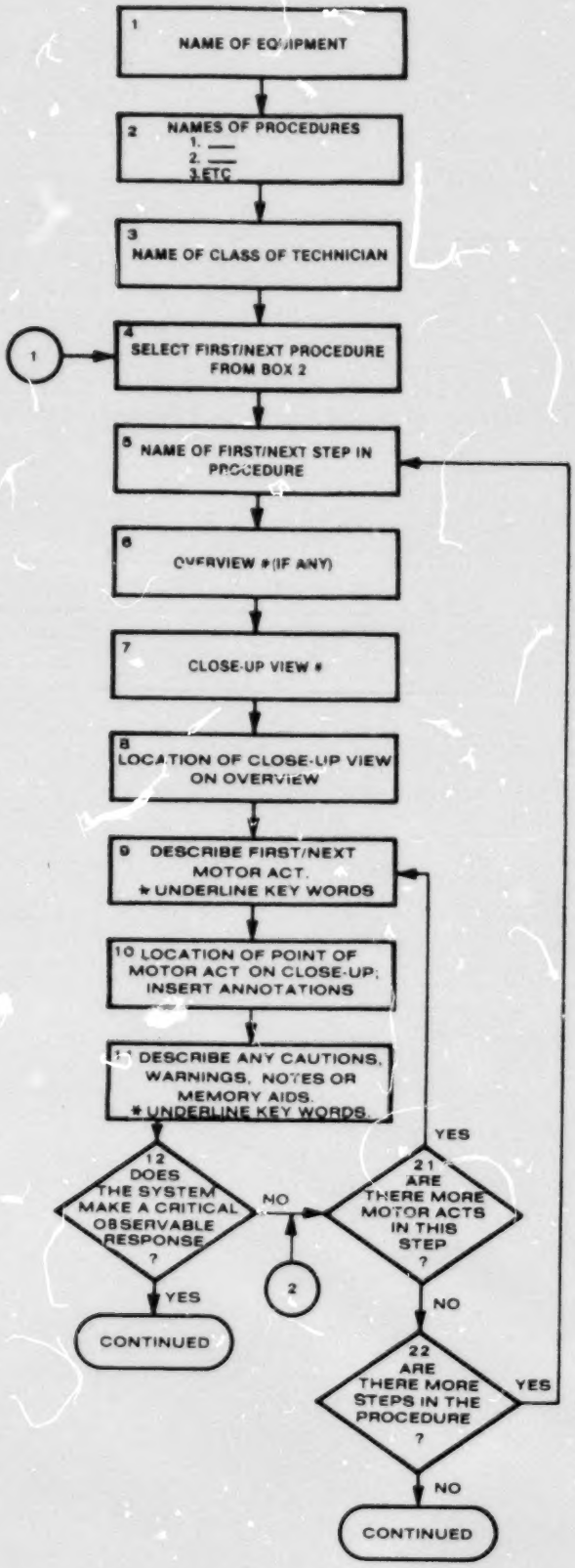
1 NAME OF EQUIPMENT
2 NAMES OF PROCEDURES 1. — 2. — 3.ETC
3 NAME OF CLASS OF TECHNICIAN
1
4 SELECT FIRST/NEXT PROCEDURE FROM BOX 2
5 NAME OF FIRST/NEXT STEP IN PROCEDURE
6 OVERVIEW # (IF ANY)
7 CLOSE-UP VIEW #
8 LOCATION OF CLOSE-UP VIEW ON OVERVIEW
9 DESCRIBE FIRST/NEXT MOTOR ACT. * UNDERLINE KEY WORDS
10 LOCATION OF POINT OF MOTOR ACT ON CLOSE-UP; INSERT ANNOTATIONS
11 DESCRIBE ANY CAUTIONS, WARNINGS, NOTES OR MEMORY AIDS. * UNDERLINE KEY WORDS.
12 DOES THE SYSTEM MAKE A CRITICAL OBSERVABLE RESPONSE ?
NO
YES
21 ARE THERE MORE MOTOR ACTS IN THIS STEP ?
YES
NO
2
CONTINUED
22 ARE THERE MORE STEPS IN THE PROCEDURE ?
YES
NO
CONTINUED

Figure 6. Parts of a Routine for Building a Computer Data Base on a Set of Procedures.

Therefore a computer aided authoring system for Navy technical training must be able to handle visual information as readily as text.

Second, similar kinds of job-tasks can be taught using standard formats. This makes feasible the repeated use of computer routines for generating classes of instructional materials. A description of using computer routines in authoring training materials for different classes of training illustrates this point.

The teaching of weather symbols, Navy flags and Morse code represent a particular class of learning - symbol learning which is a form of paired associate learning. The learning of each of these symbol sets can be carried out with nearly the same formats and sequence of learning events.

Perhaps the most common class of learning in Navy training is the learning of procedures - maintenance procedures and equipment operating procedures. Again, different procedural job-tasks can be taught with similar machine producible formats and a standard sequence of learning events.

This approach to authoring instructional materials is optimized to produce materials with similar structure for similar types of learning tasks and depends upon editing to accommodate the special requirements of individual tasks. Computer aids will be useful in this type of authoring. This approach is basically different than the traditional method of authoring which emphasizes the differences among learning tasks. In the traditional approach the author perceives the learning task to be unique, and rarely sees the opportunity to use standard formats.

COMPUTER AIDED EDITING

Figures 7, 8, and 9 illustrate using the computer readability editing system as part of a computer-based publishing system. It can be used with the computer aided authoring system, or as illustrated here, with traditionally authored text. The two computer printouts contain "before" and "after" examples of a safety warning intended for foreign technicians who read English at the eighth grade level. The original version, figure 7 in the left hand column, is at the college level of readability. The rewritten version, figure 8 in the right hand column, has been revised based on suggestions

provided by the system to be at the eighth grade readability level. Specific features of the system (shown in figure 7 with callouts) are as follows:

1. Long sentences are flagged and the number of words in the sentence is shown between dollar signs: in this case "32."

2. Replacements for awkward words and phrases are suggested: in this case "aid" or "help" are suggested as replacements for "assistance."

3. Uncommon words are flagged: in this case "reliance."

4. Keying errors and misspelled words are flagged: in this case, "voltagesfrom" and "equiptment."

5. Passive verbs are flagged: in this case "be removed." A passive verb is composed of a form of the auxiliary verb "to be" plus a past participle, in this case "be removed." Language experts agree that the active verb (in this case "remove") is generally easier to understand.

6. The readability grade level calculated according to the Department of Defense readability standard, the Flesch-Kincaid Formula, is shown: in this case "14.0."

Figure 9 is the camera ready version of the text which can be automatically generated from the final approved text shown in figure 8.

The readability editing technique has been thoroughly tested feature by feature. We have used tens of thousands of words of military text as test material such as trouble shooting instructions, multiple choice tests, narrative instructional material, and safety warnings.

For more description of the development and use of the system, see Kincaid, Aagard and O'Hara (3) and Kincaid, Aagard, O'Hara and Cottrell (4).

The features of the system illustrated in figure 7 have generally worked well in analyzing this wide variety of text. If a feature didn't work (for example, our earlier version of the common word list) the printouts pointed this out forcefully. After two years and several man-years of effort the present routines emerged.

One current project illustrates the value of the system for writing materials for high readability using controlled vocabulary - which is what the system was designed to do. We are writing a workbook to be used to supplement the Naval Junior ROTC third year text at the eighth grade readability level, with a limited vocabulary and with difficult words defined. The author (an English Professor) is a skilled and experienced writer but until this project had never had to be concerned with the reading difficulty of his publications.

At the onset of the project, we were unsure about the value of the system to a skilled writer but were committed to analyze the text (to assess readability grade level and choose uncommon words for glossaries at the end of each chapter). To our pleasant surprise, the author used many of the computer generated suggestions. While he had no difficulty writing to the eighth grade level, the analysis verified his success in this regard. We picked words for the glossaries mostly from the list of uncommon words generated as part of the analysis. Since we are using the same textstream for producing the drafts and finally the camera ready copy, the proof-reading aspects of the system are saving time.

Clearly the computer readability editing system has proved its worth in this particular application.

It should be noted that several companies have been developing and using computers to make text more readable, for example, General Motors and Bell Laboratories. The uniqueness of TAEG's routines stems from the fact that they have been specifically developed and are being systematically validated for use by the military services.

FUTURE DEVELOPMENTS

Using computers for the initial stages of authoring and editing is an idea whose time has come. Computers are being routinely used in the production phases of publishing and therefore are available for these "front-end" functions. Well conceived and thoroughly tested author aiding software routines have been lacking. We feel that the routines described in this paper are good prototypes which will be further developed and improved with more use.

The Navy is considering implementing both the authoring and readability editing routines as part of

Do not
~~Under no circumstances should any person~~
reach within or enter the enclosure ~~for the purpose of servicing~~ to service or adjust~~ing~~ the equipment ~~without presence of assistance (AID/HELP) of~~ by yourself. Make sure another person able to help is with you.

~~rendering (GIVING/MAKING) and~~ Do not depend upon door switches or interlocks for protection; ~~but~~ always shut down motor generators or other equipment. ~~Under no circumstances~~ Do not remove or short ~~should~~ circuit any access gate, door, or other safety interlock switch ~~be removed~~. (!PASSIVE VOICE!)

~~short circuited, or tampered with in any way by other than~~ Only authorized maintenance personnel ~~nor should reliance be placed (!PASSIVE VOICE!) upon~~ can do this. Do not depend on the interlock switches for removing [voltages from] the [equipment.]

Number of Sentences
4

Number of Words
94

Number of Syllables
183

Avg. Number of Words per Sentence
23.50

Avg. Number of Syllables per Word
1.73

GRADE LEVEL
(Based on DOD Readability Standard)
14.0

WORDS NOT ON COMMON WORD LISTS

WORD	FREQ
equiptment	1
reliance	1
short-circuited	1
tampered	1
voltagesfrom	1

Figure 7. Original Version of a Warning Statement Analyzed with Computer Readability Editing Routines and Showing Editor's Changes.

Do not reach within or enter the enclosure to service or adjust the equipment by yourself. Make sure another person able to help is with you. Do not depend upon door switches or interlocks for protection; always shut down motor generators or other equipment. Do not remove or short circuit any access gate, door, or other safety interlock switch. Only authorized maintenance personnel can do this. Do not depend on the interlock switches for removing voltages from the equipment.

Number of Sentences
7

Number of Words
79

Number of Syllables
126

Avg. Number of Words per Sentence
11.28

Avg. Number of Syllables per Word
1.59

GRADE LEVEL
(Based on DOD Readability Standard)
7.0

Figure 8. Rewritten Version of Same Warning Statement Analyzed with Computer Readability Editing Routines.

WARNING

Do not reach within or enter the enclosure to service or adjust the equipment by yourself. Make sure another person able to help is with you. Do not depend upon door switches or interlocks for protection; always shut down motor generators or other equipment. Do not remove or short circuit any access gate, door, or other safety interlock switch. Only authorized maintenance personnel can do this. Do not depend on the interlock switches for removing voltages from the equipment.

Figure 9. Typeset Warning Statement Generated from Textstream in Figure 8.

the Naval Technical Information Presentation System (NTIPS). This type system will be described later in this session by John Bean. It is a computer-based publishing system being designed to produce the full range of technical information needed to support new equipment. This includes not only the support of systems operation and maintenance, but also such things as training and logistics. The information will be delivered in any number of media - both electronic and hard copy. Plans call for implementing the NTIP System by 1985. However, some parts of the system can be implemented now. This will soon include the TAEG computer aided authoring and editing routines.

Within the next five years we envision that many of the following additional computer routines to aid authors will be developed and implemented.

- Files of standard information. These could be used to automatically produce such things as glossaries and warning and caution statements.

- Routines to compose sets of documents. Reference manuals, job performance aids, and learning aids for a piece of equipment will be produced automatically as a set from a single data base.

- Routines for nomenclature control. This is a common problem today because different technical writers tend to use different common names for the same equipment component.

- Additional checks for readability. Readability standards such as those suggested by Klare (5) and Kniffin (6) could be automatically checked, such as using positive rather than negative sentence construction.

- Checks on composition practices. Style standards such as those devised by Price (7) could be automatically checked, for example the requirmnt for one heading per every two paragraphs and the limiting of paragraphs to 60 words.

- Quality assurance. Many kinds of contractually required data, for example, readability grade level, could be automatically generated for internal use by contractors and for furnishing to government agencies.

- Author training. We have observed that the computer readability editing system is an effective author training device. Further development of this feature is reasonable given the shortage of trained technical writers.

One last note. This paper was produced with the aid of TAEG's computer aided authoring text processor and readability editing routines and was typeset using the same textstream. It is written at the 10th grade readability level; clearly this doesn't exceed the reading level of this highly intelligent audience.

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J. PETER KINCAID is the team leader of the readability projects for the Navy's Training Analysis and Evaluation Group in Orlando, Florida. He has a Ph.D. in experimental psychology from Ohio State University and is the author of many articles and technical reports on readability and other subjects, such as remediation and human memory. His readability formula, a recalculation of the Flesch Reading Ease formula, has been adopted by the Department of Defense (MIL-M-38784A, Amendment 5, 24 July 1978).